

## IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

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Applicant(s): Milan Kokta, et al.

Title: SPINEL ARTICLES AND METHODS FOR FORMING SAME

App. No.: 10/669,135

Filed: September 23, 2003

Examiner: Matthew J. Song

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## MS AMENDMENT

Commissioner for Patents

PO Box 1450

Alexandria, VA 22313-1450

## DECLARATION UNDER 37 C.F.R. §1.132

I, Jennifer Stone-Sundberg, hereby declare and state:

1. I am a co-inventor of the above-identified patent application.
2. I have reviewed the Office Action dated July 24, 2006, as well as the prior art cited therein.
3. The claimed invention is drawn to a Czochralski method of forming single crystal spinel wafers from a melt. According to the invention, a spinel single crystal boule is grown from a melt, the boule having the general formula of  $aAD \cdot bE_2D_3$ , in which the ratio of  $b:a$  is greater than 1.5:1 such that the spinel is rich in  $E_2D_3$ . Thereafter, the boule is sliced into wafers. Of particular significance, the single crystal boule is formed at a process aspect ratio of not less than about 0.44. The process aspect ratio is defined as a ratio of average boule diameter to crucible inside diameter.

The claimed process aspect ratio in the context of the Czochralski method is responsible for quite significant properties of the boule. Namely, by growing the boule at a process aspect ratio not less than about 0.44, undesirable crystallographic "flipping" is prevented. In addition,

multiphasic (crystallographic twinning, the boule having multiple crystal phases), is also prevented.

The forgoing beneficial effects of forming spinel boules at a high aspect ratio were discovered by me and my co-inventors *empirically*, the crystallographic effects not being predicted by any particular scientific theory or formulaic methodology. Indeed, we found the benefits of high process aspect ratio to be quite surprising, and today still remain unclear on the precise technical reasons why high process aspect ratio in the context of non-stoichiometric spinel crystal growth has been shown to have benefits mentioned above. In this regard, typically crystal growth scientists seek to minimize the mass of the growing crystal relative to the mass of the melt from which it is drawn. That is, by minimizing the mass of the growing boule relative to the melt, a large melt fraction is maintained in the crucible, which helps ensure homogeneous crystal growth and undesirable shifts in the stoichiometry of the melt. Minimizing the mass of the growing crystal relative to the melt dictates a low process aspect ratio. Accordingly, large size boules are generally achieved through scaling of the mass of the melt and crucible, not by increasing boule size relative to the mass of the melt and crucible. This simplistic approach, increasing boule size for a given melt/crucible, has been found in the art to deteriorate crystal quality.

I emphasize that not only does the prior art fail to recognize issues like crystallographic flipping and crystallographic twinning associated with Czochralski growth of spinel boules, but also fails to suggest utilizing a high aspect ratio to address those technical issues. Indeed, based upon my years of experience in the crystal growing field and experience of my colleagues including my co-inventors, I personally find the attendant benefits of utilizing a high process aspect ratio (not less than about 0.44) to be surprising and unexpected, and believe that one of ordinary skill in the art would find the attendant results to be unexpected. And further, based on the prior art, which is silent on process aspect ratio, it would not have been obvious to one of ordinary skill in the art to operate the described growth processes at a process aspect ratio not less than 0.44.

4. I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further, that these statements were made with the knowledge that willful false statements and the like, so made, are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001 and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Respectfully submitted,

\_\_\_\_\_  
Date

\_\_\_\_\_  
Jennifer Stone-Sundberg